Statistical modeling of hydraulic design loads

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HKV Consultants

HKV Consultants

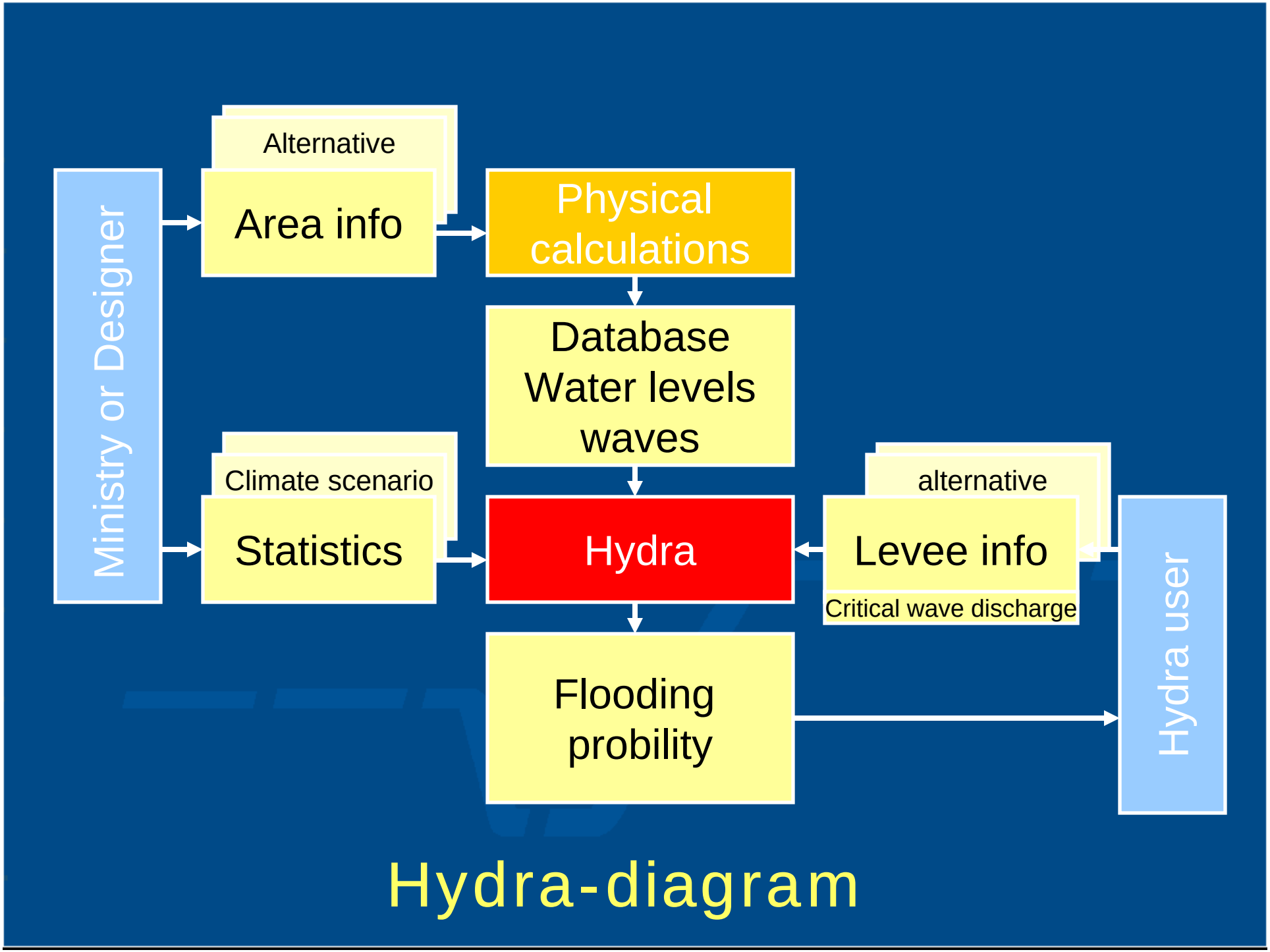
- Small company (50 persons, 80% academic)
- Founded in 1995
- Focus on probabilistic methods in flood risk management (assessment of probabilities, economic damage, cost-benefit analysis)
- Multiple disciplines: civil engineering, mathematics, programming, ...
- Collaboration with universities (supporting professor in risk analysis of water systems, PhD students, MSc students)

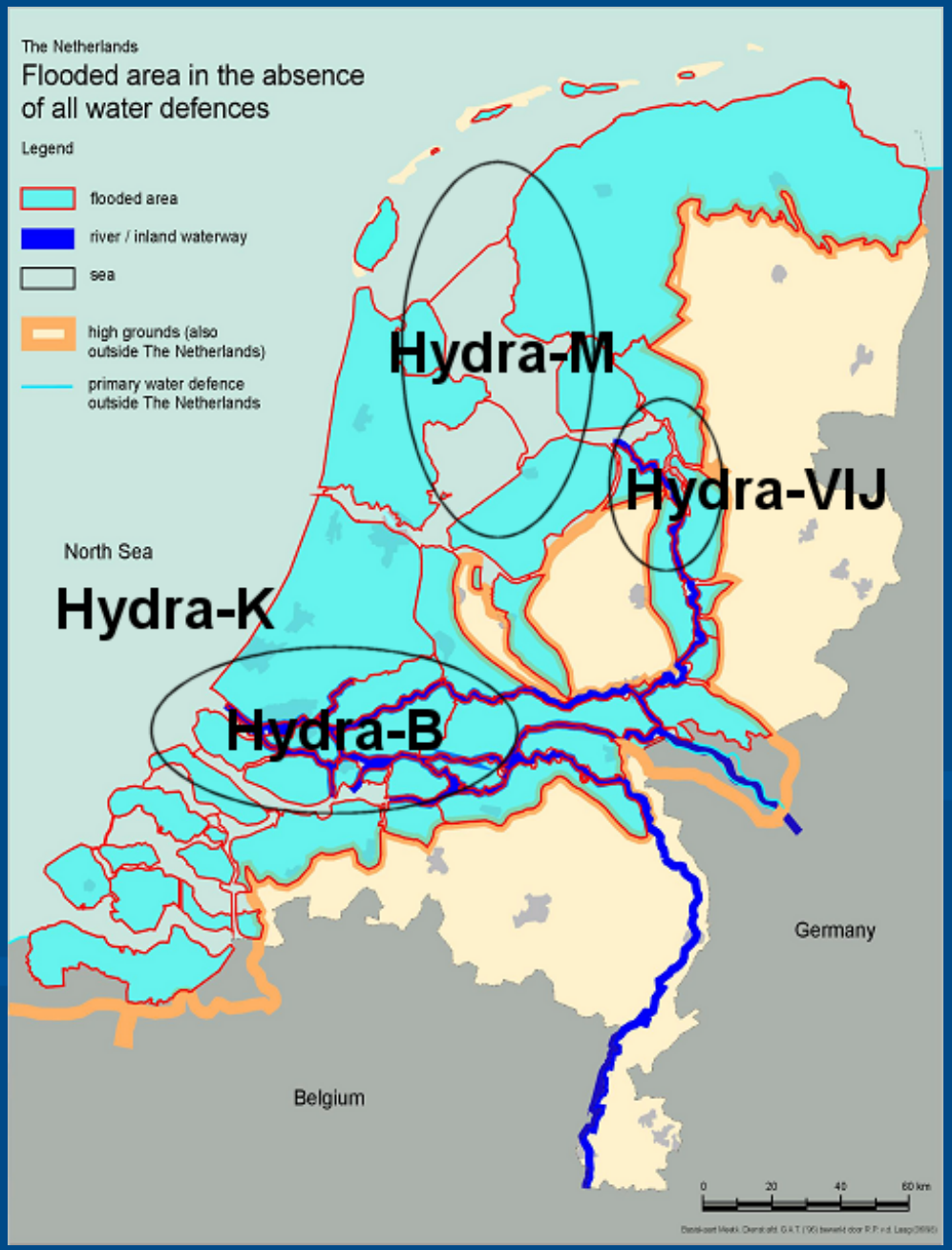
Topics

- The concept of probabilistic assessment
- Stochastic variables
- Example: HYDRA-B

Probabilistic assessment

- Combination of physical models and statistics
- Main issue: how to combine the stochastic variables with different time scales?
- Stochastic variables not always independent
- Each system has its properties and requires different approach


Alternative
Area info
Physical calculations
Ministry or Designer
Database
Water levels
waves
Climate scenario
Statistics
Hydra
alternative
Levee info
Critical wave discharge
Hydra user
Flooding
probility
Hydra-diagram


The Netherlands
Flooded area in the absence of all water defences
Legend
flooded area
river / inland waterway
sea
high grounds (also outside The Netherlands)
primary water defence outside The Netherlands
Hydra-M
Hydra-VIJ
North Sea
Hydra-K
Hydra-B
Germany
Belgium
0
20
40
60 km

Four Hydra-programs

- COAST: Hydra-K (correlation between water levels and wind)
- TIDEL-RIVER: Hydra-B (tidel time scale and river time scale, correlation between wind speed and sea water level)
- LAKE: Hydra-M (water levels, wind set-up and waves)
- LAKE-RIVER: HYDRA VY (water levels, wind set-up, river discharge)

Hydra-B: tidal – river area

The probabilistic model takes the following variables into account:

- Rhine discharge
- Meuse discharge
- Sea water level
- The wind speed over the area
- The wind direction over the area
- Failure of storm surge barriers

Hydra-B - About

Hydra-B

Assessment program for the height of flood defences in the tidal river area of The Netherlands

Version 3.1.0

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Benedenrivieren: Version: 1.10.1 September 2004
Overslagdebiet: Version: 1.0.1 September 2004

Developed by Ministry of Transport, Public Works and Water Management/RIZA and ®HKV consultants

Client:
Ministry of Transport, Public Works and Water Management/RIZA

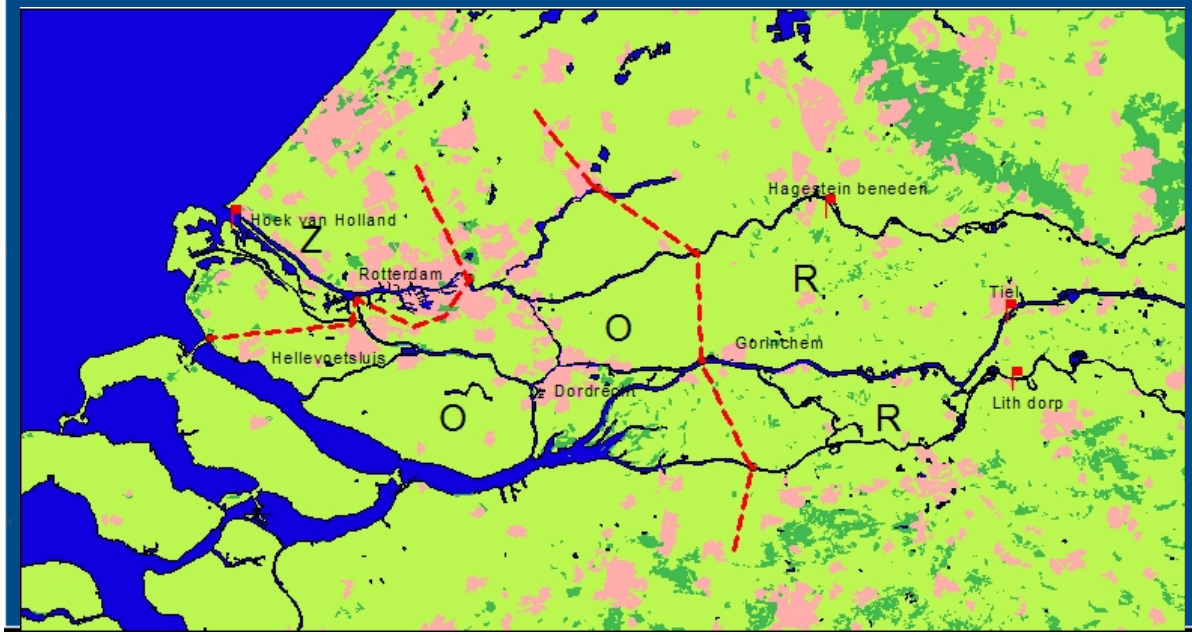
Implemented by:
®HKV consultants

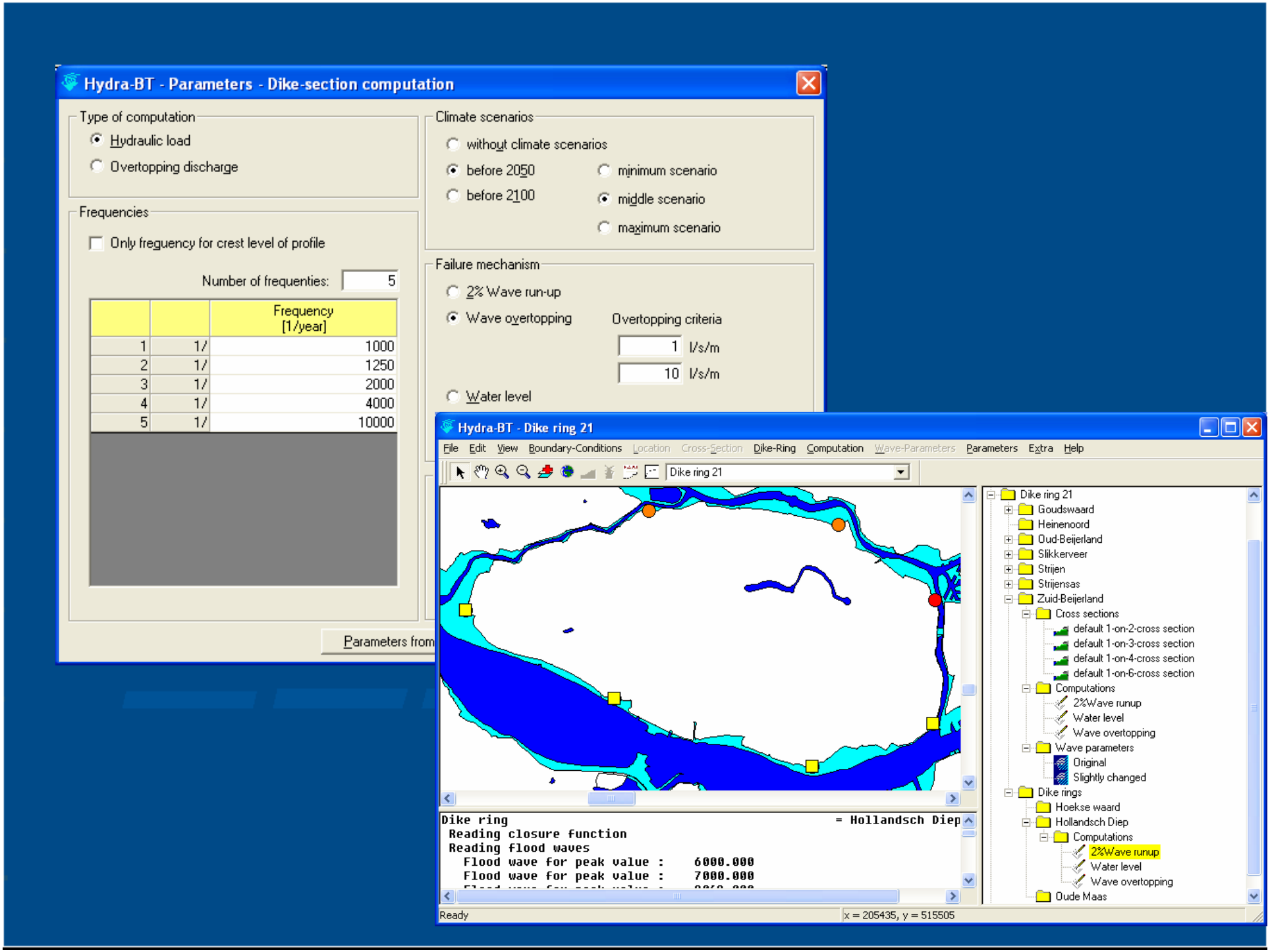
for questions visit
www.waterkeren.nl
or send an email to the help desk

OK

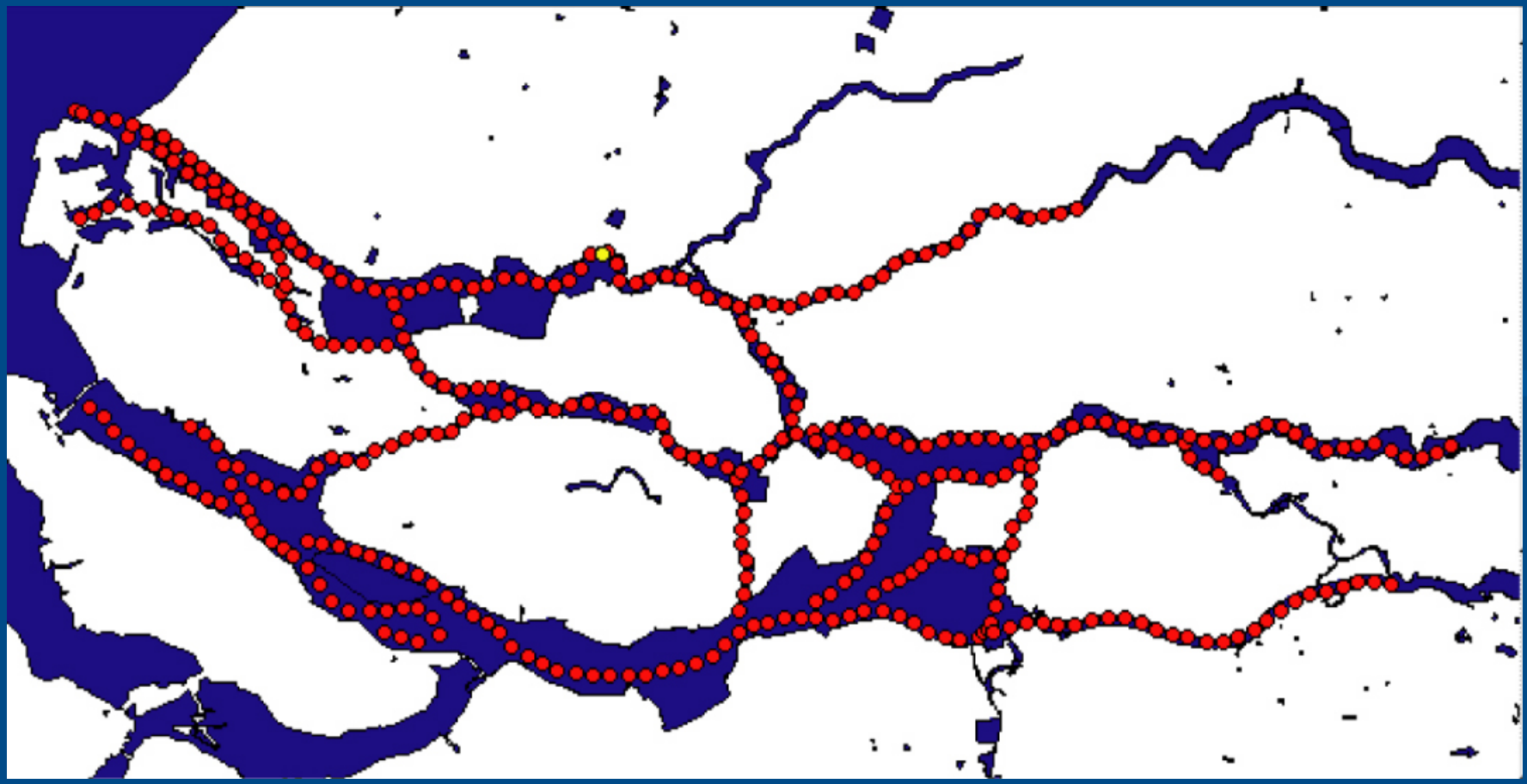
Three areas

- The sea area. Storm floods and high wind speeds and cause wind generated waves
- The river area. Extreme discharges, wind speeds are not very high
- The transition area. Not only tidal storms and high wind speeds, but also high discharges

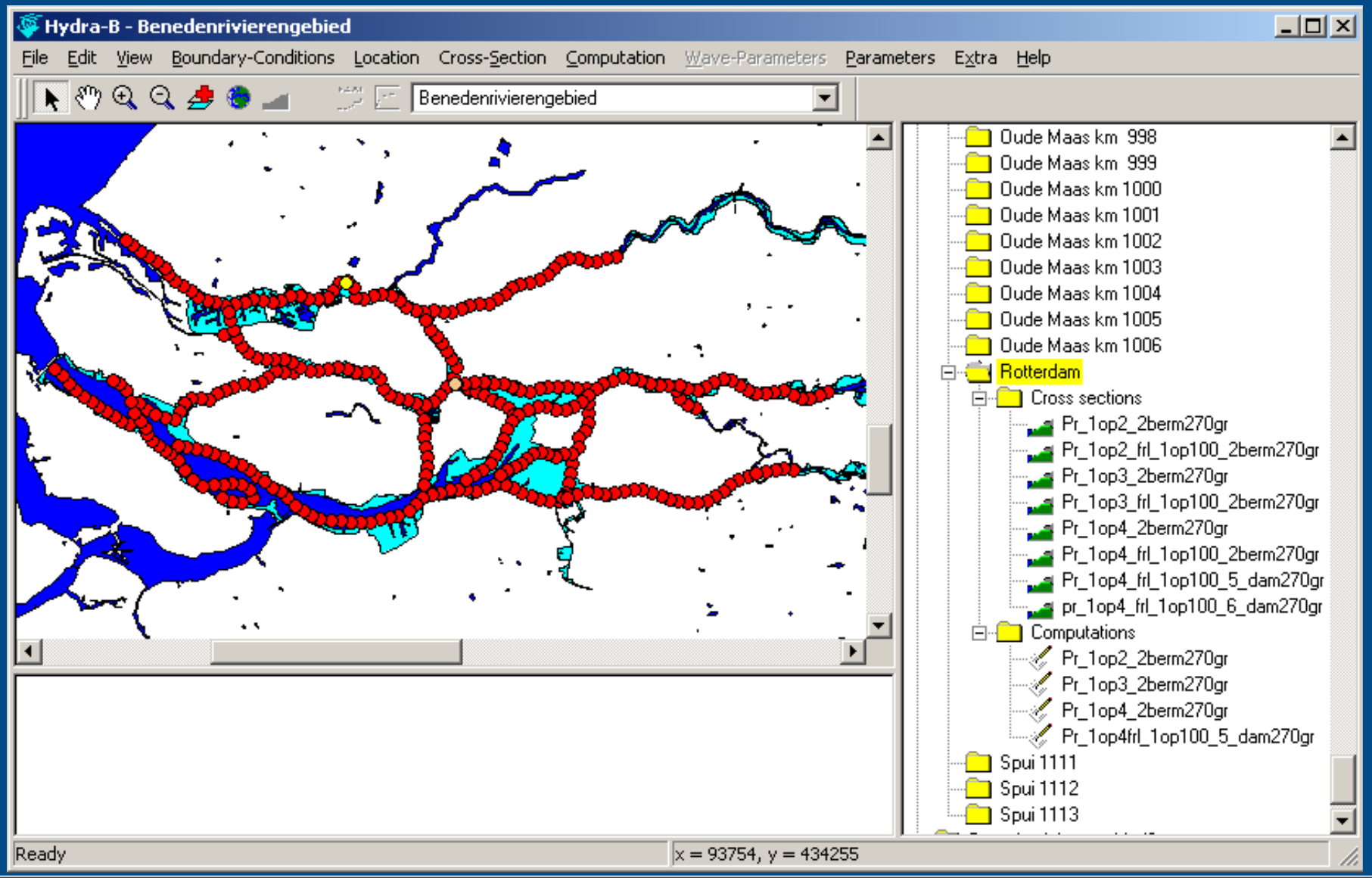



Hydra-BT - Parameters - Dike-section computation
Type of computation
Hydraulic load
Overtopping discharge
Frequencies
Only frequency for crest level of profile
Number of frequenties: 5
Frequency [1/year]
1 1/ 1000
2 1/ 1250
3 1/ 2000
4 1/ 4000
5 1/ 10000
Climate scenarios
without climate scenarios
before 2050
before 2100
minimum scenario
middle scenario
maximum scenario
Failure mechanism
2% Wave run-up
Wave overtopping
Overtopping criteria
1 l/s/m
10 l/s/m
Water level
Parameters from
Hydra-BT - Dike ring 21
File Edit View Boundary-Conditions Location Cross-Section Dike-Ring Computation Wave-Parameters Parameters Extra Help
Dike ring 21
Dike ring = Hollandsch Diep
Reading closure function
Reading flood waves
Flood wave for peak value : 6000.000
Flood wave for peak value : 7000.000
Dike ring 21
Goudswaard
Heinenoord
Oud-Beijerland
Slikkerveer
Strijen
Strijensas
Zuid-Beijerland
Cross sections
default 1-on-2-cross section
default 1-on-3-cross section
default 1-on-4-cross section
default 1-on-6-cross section
Computations
2%Wave runup
Water level
Wave overtopping
Wave parameters
Original
Slightly changed
Dike rings
Hoekse waard
Hollandsch Diep
Computations
2%Wave runup
Water level
Wave overtopping
Oude Maas
Ready
x = 205435, y = 515505

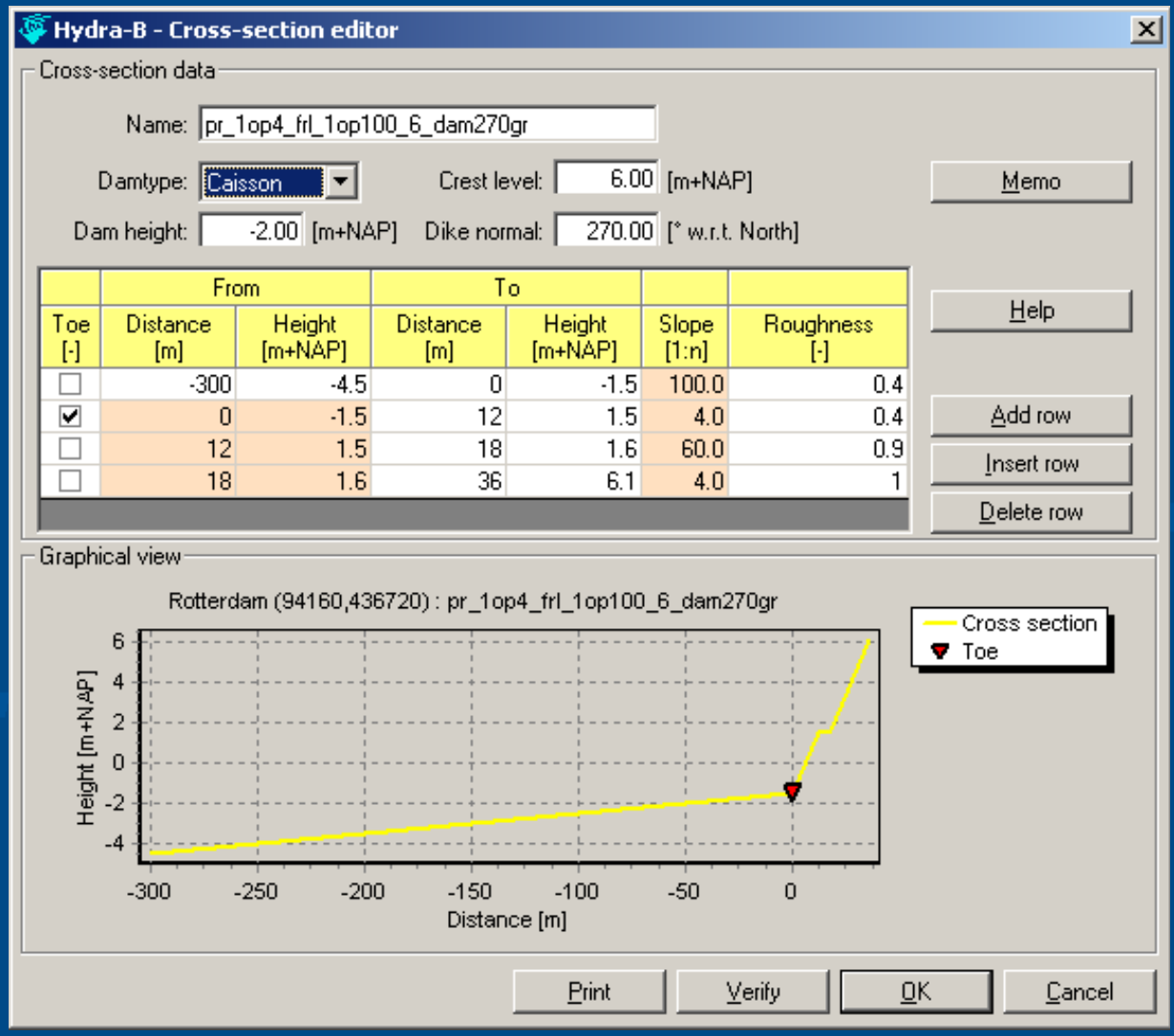
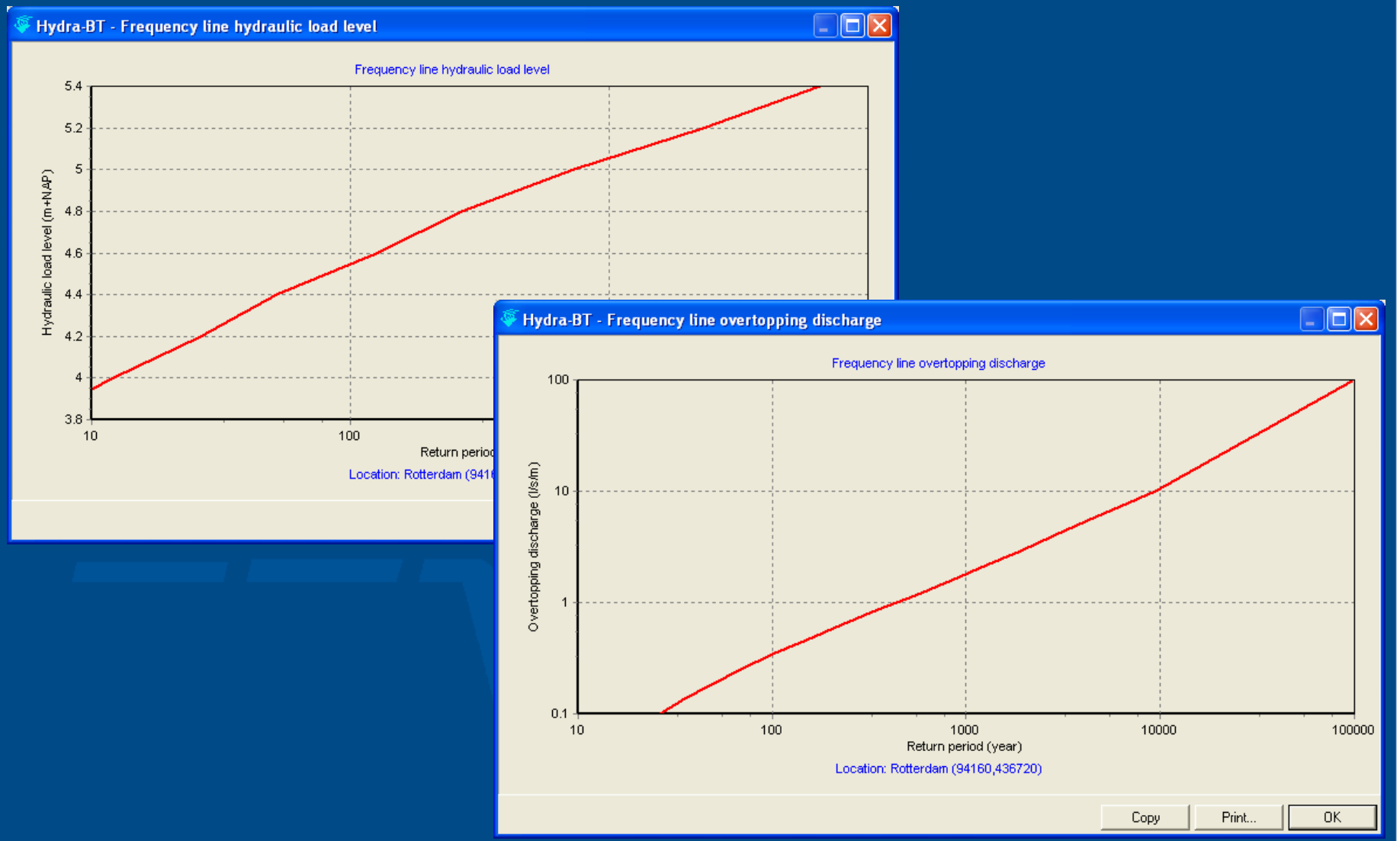
GIS information (location points)



Main screen


Hydra-B - Benedenrivierengebied
File Edit View Boundary-Conditions Location Cross-Section Computation Wave-Parameters Parameters Extra Help
Benedenrivierengebied
Oude Maas km 998
Oude Maas km 999
Oude Maas km 1000
Oude Maas km 1001
Oude Maas km 1002
Oude Maas km 1003
Oude Maas km 1004
Oude Maas km 1005
Oude Maas km 1006
Rotterdam
Cross sections
Pr_1op2_2berm270gr
Pr_1op2_frl_1op100_2berm270gr
Pr_1op3_2berm270gr
Pr_1op3_frl_1op100_2berm270gr
Pr_1op4_2berm270gr
Pr_1op4_frl_1op100_2berm270gr
Pr_1op4_frl_1op100_5_dam270gr
pr_1op4_frl_1op100_6_dam270gr
Computations
Pr_1op2_2berm270gr
Pr_1op3_2berm270gr
Pr_1op4_2berm270gr
Pr_1op4frl_1op100_5_dam270gr
Spui 1111
Spui 1112
Spui 1113
Ready
x = 93754, y = 434255

Cross-section editor



Example of output